# Navigation Program

# Workshop

## A High Resolution Acoustic Imaging Camera for the Inspection of Underwater Structures

## April 18 2006

*Presentation by*
*Mr. Jim Evans*
*ERDC_ITL ,*
*Vicksburg, MS*

# High Resolution Acoustic Imaging Camera

- High Resolution Acoustic Imaging Sonar, which had its origins in the medical imaging industry, has been developed by DoD for underwater use.

- This type equipment will benefit the Corps' structural inspection activities by reducing inspection cost and decreasing personnel risk. This is particularly true in those cases where turbid water exist. Other areas within the Corps mission area that will benefit from the technology will be wet construction, environmental and cultural artifacts.

- Through the Navigation program, ERDC is actively working with Corps' Districts and Divisions to bring this Technology to the Field

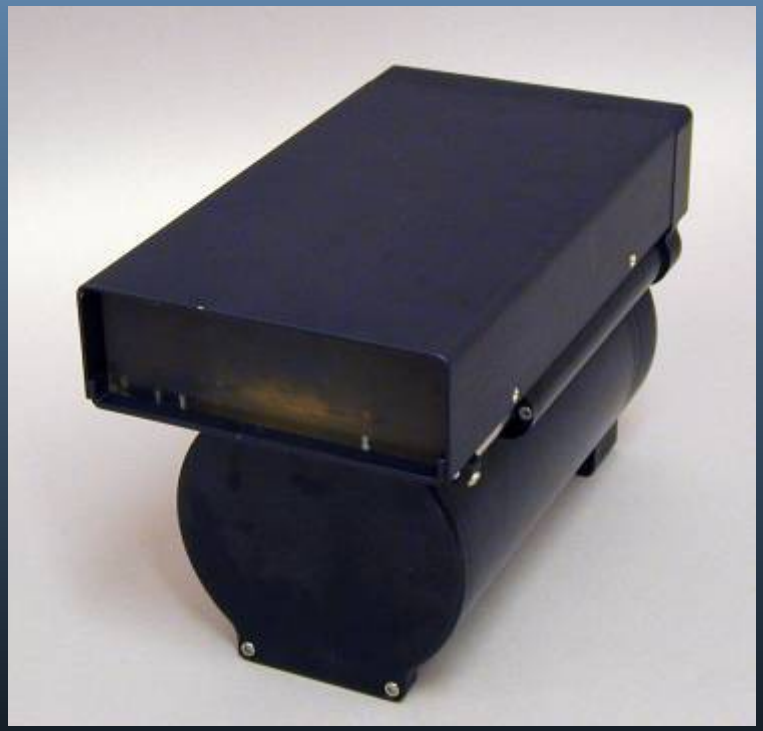
- The efforts are two fold;
  - 1) Develop the optimum deployment methods
  - 2) Improve the images by developing appropriate algorithms

ERDC
Engineer Research and Development Center
Vicksburg Mississippi

# *High Resolution Underwater Acoustic Imaging Sonar*

## DIDSON
### (Dual Frequency Identification Sonar)

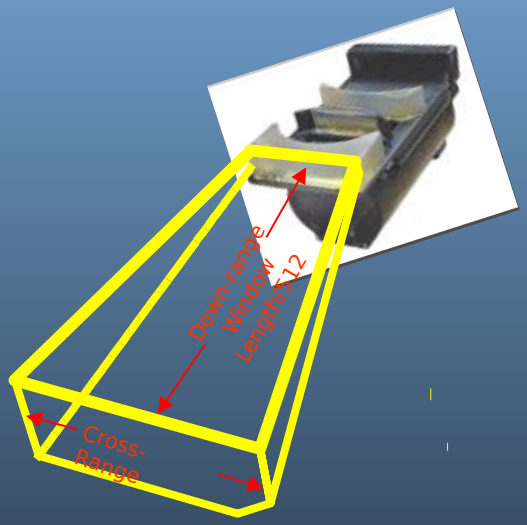
**Specifications:**



- **The DIDSON Acoustic Imaging camera has 2 individually selectable operating frequencies 1.0 Mhz and 1.8 Mhtz.**
- **The DIDSON uses variable focus acoustical lenses which reduces system size and reduces power consumption.**
- **The DIDSON has  resolution in the millimeter range (at short distances 3-4 meters) using a linear arrays**
- **The DIDSON has a high frame rate of >20 per sec. (for dynamic images)**

ERDC
Engineer Research and Development Center
Vicksburg Intranet

# High Resolution Acoustic Imaging Camera



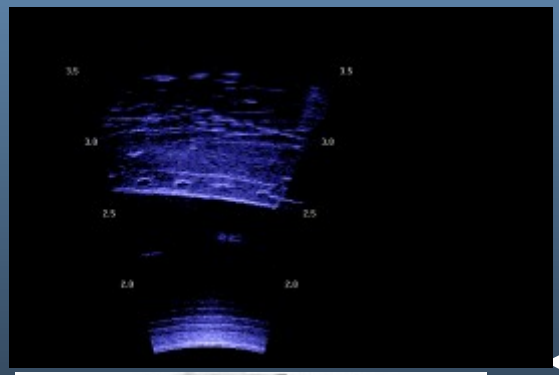

1) In high frequency, 1.8 MHz mode, each beam is 0.3° in the horizontal and 14° in elevation. There are 96 beams shoulder-to-shoulder spanning 28.8° in the horizontal direction.

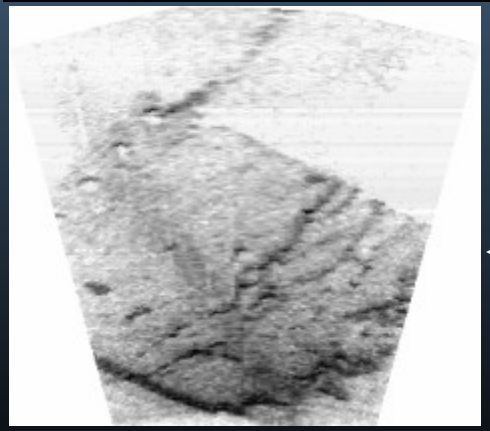
2) The cross range of the field of view varies with down range. The cross range is half (R/2) the down range (R) at that range. That means that at 10 meters out, the cross range of the display (from beam 1 to beam 96) is 5 meters. The horizontal width of each beam at 5 meters range is 500/96 or approximately 5 cm.

3) The height of each beam is approximately .25 times the down range. So 10 meters out the height would be 2.5

# High Resolution Acoustic Imaging Camera

## Inspection of Underwater Structures





***High Resolution Imaging Sonar can be used for:***

- Construction (positioning)
- Maintenance
- Safety Inspections

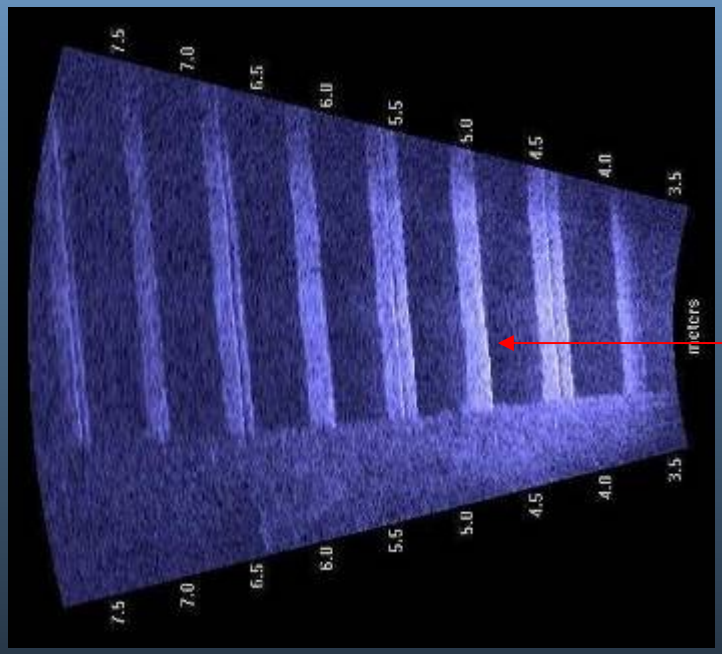
***Image Enhancements Through Post Processing:***

- Image 1 - Photo (Damaged Block)
- Image 2 - Raw acoustic image
- Image 3 – Some processing done

# High Resolution Acoustic Imaging Camera

## ERDC/St.Louis/Louisville Districts Field Demo

### (18 March 02 - Cape Girardeau and Olmstead Lock and Dam)



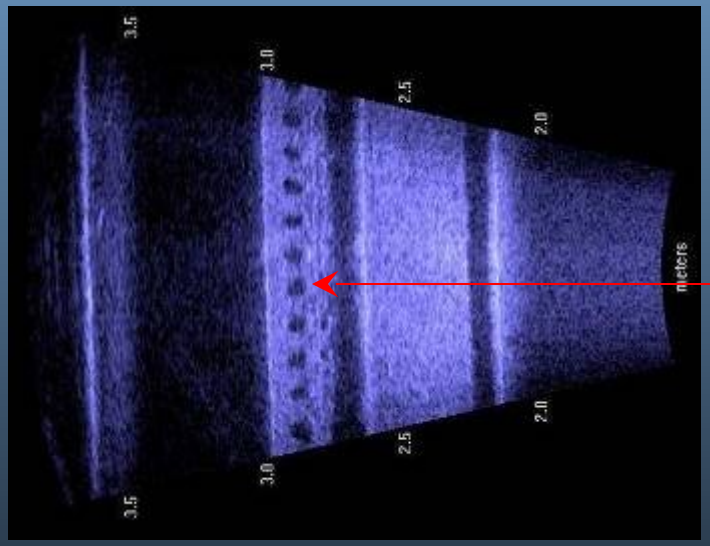

**Acoustical Image of Lower Ridged Casing**

**Photo of Upper Ridged Casing**

ERDC
Engineer Research and Development Center
Vicksburg Internet

# High Resolution Acoustic Imaging Camera

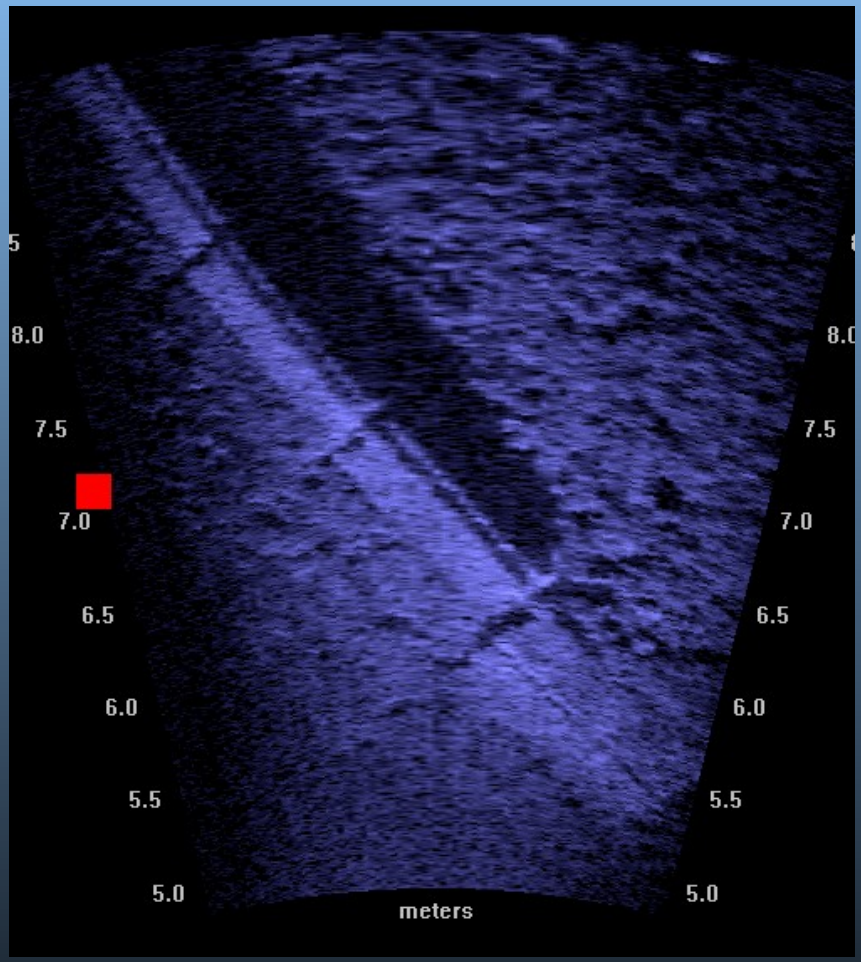
## ERDC/St.Louis/Louisville Districts Field Demo

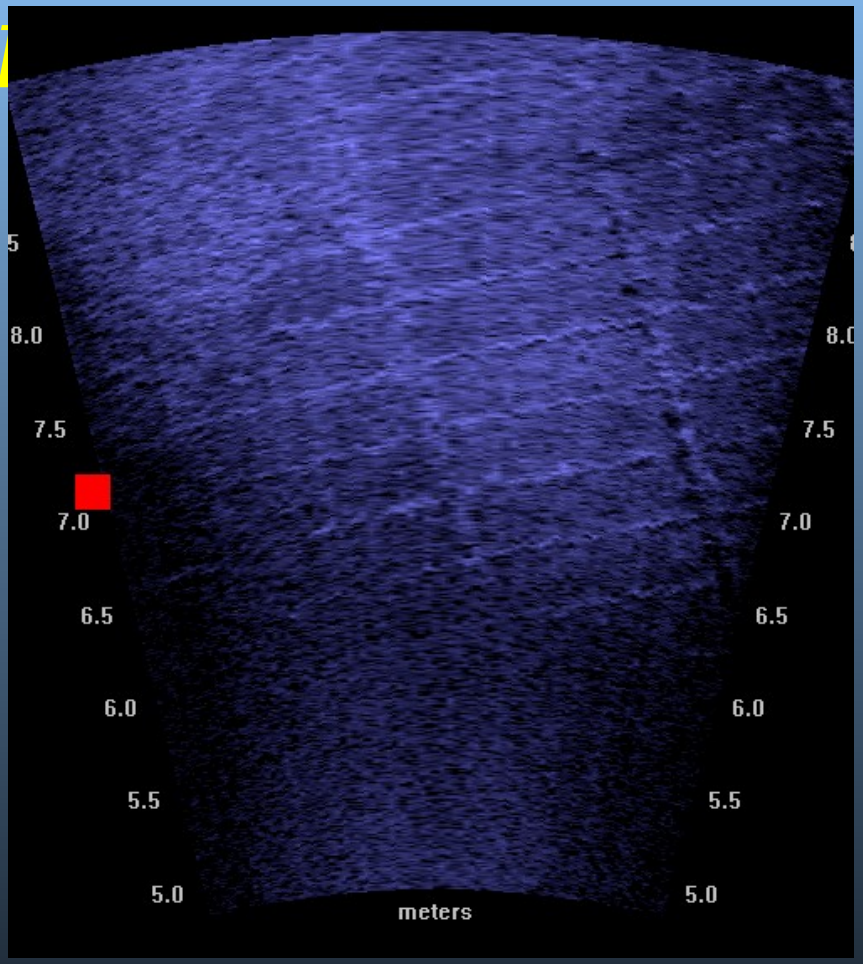



Acoustical Image of Lower Casing End-Plate

Photo of Upper Casing End-Plate

# High Resolution Acoustic I

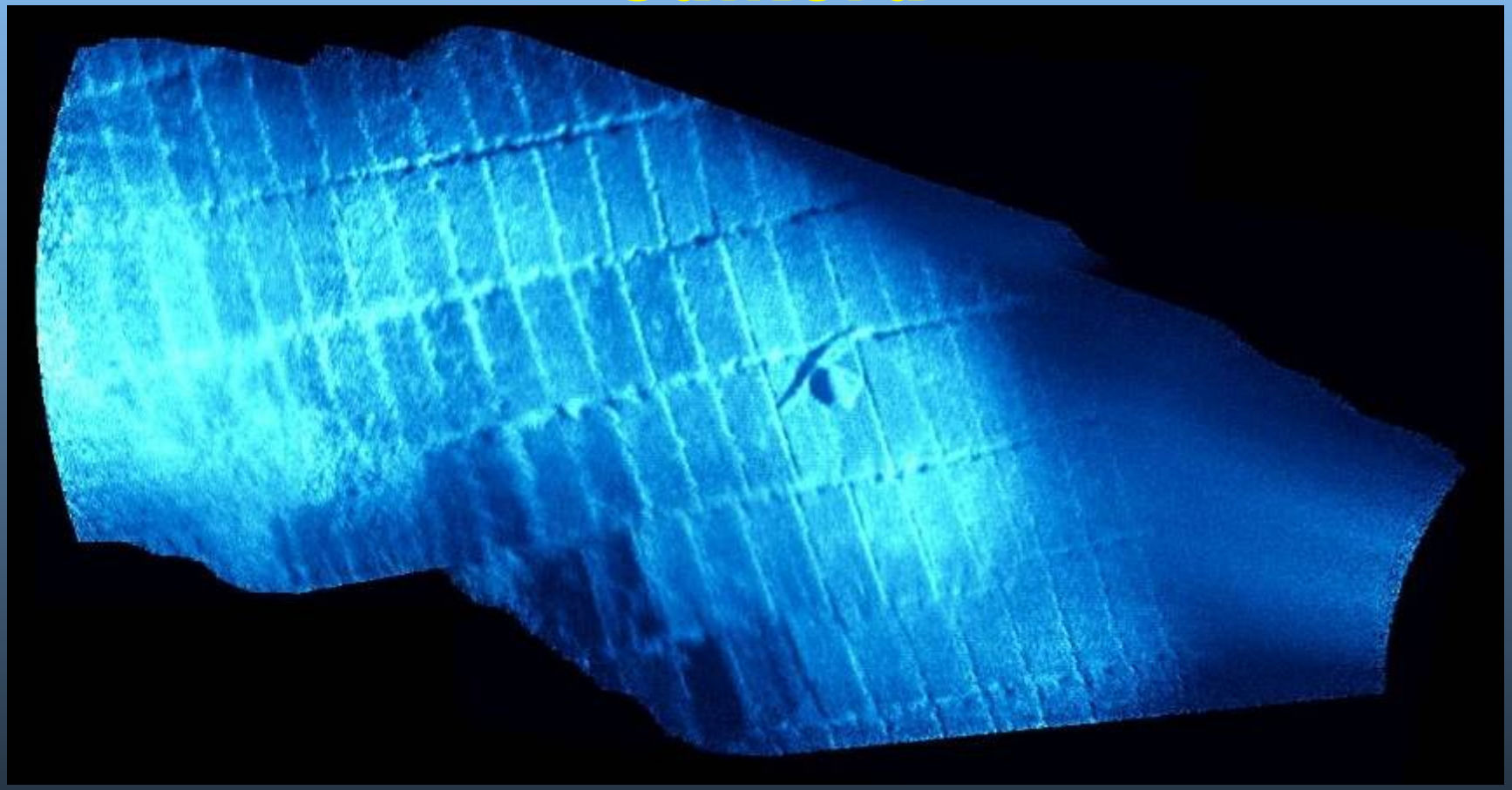



Images of Mississippi River Bank Matting

ERDC
Engineer Research and Development Center
Vicksburg Internet

# High Resolution Acoustic Imaging Camera



age of Mississippi River  Bank Matting with improved image processing and mult
Imaged mosaiced together

# High Resolution Acoustic Imaging Camera

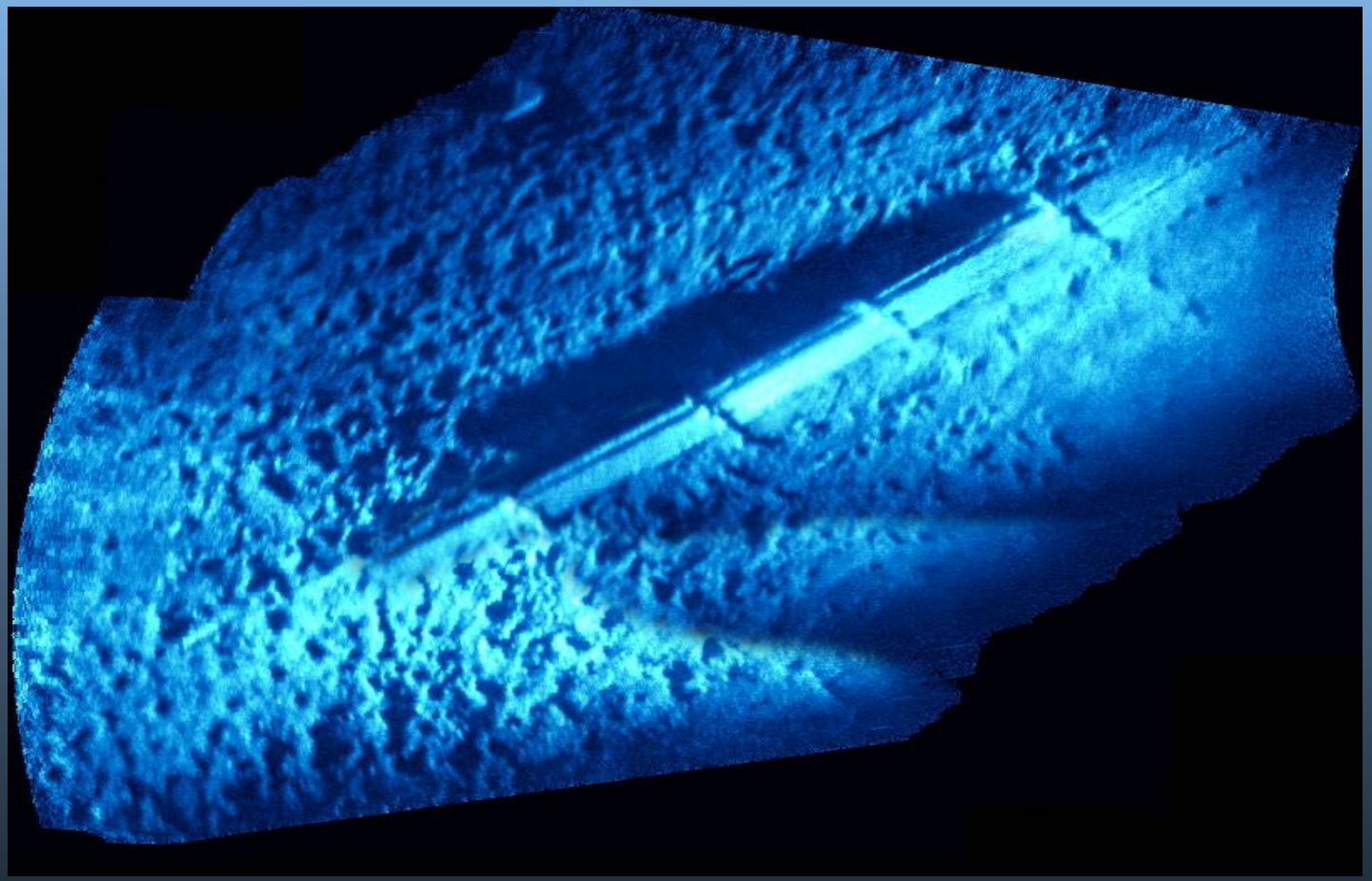
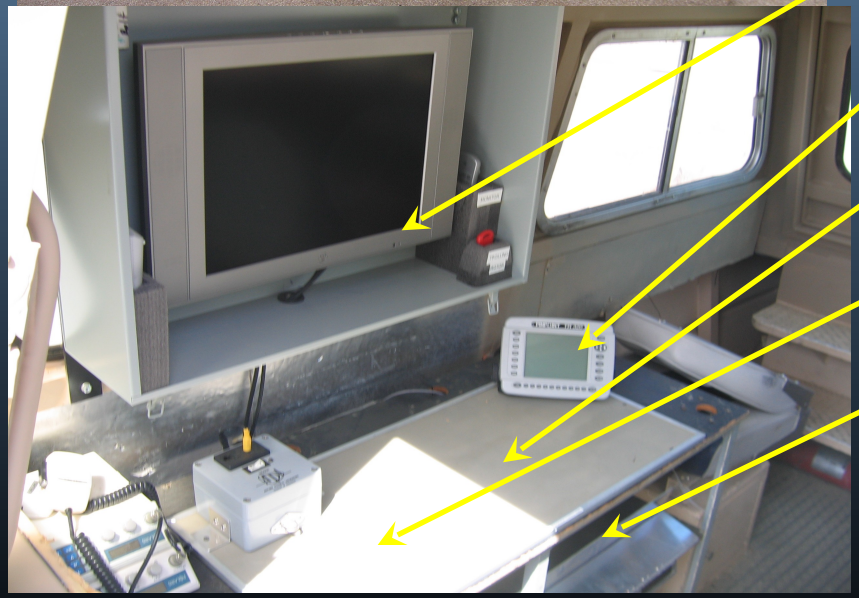


Image of Mississippi River  bank matting. The bottom of matt covered with mud
(with improved image processing and multiple
imaged mosaiced together)

# High Resolution Acoustic Imaging Camera



## Underwater Imaging Sys

- *Electric Motor*
- *Power Generator*
- *Wide Screen Real Time Display*
- *On-Board GPS*
- *Pan and Tilt Control (Joystick)*
- *Acoustic Camera Control*
- *Data Storage (DVD)*

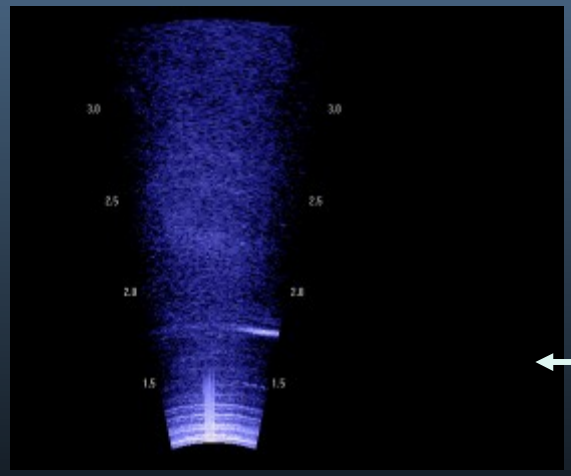
ERDC
Engineer Research and Development Center
Vicksburg Intranet

# *High Resolution Acoustic Imaging Camera*

*High Resolution imaging of underwater embankments in turbid water:*

- **Proper Placement of Rip-Rap**
- **Inspection of Levees for failure sites**

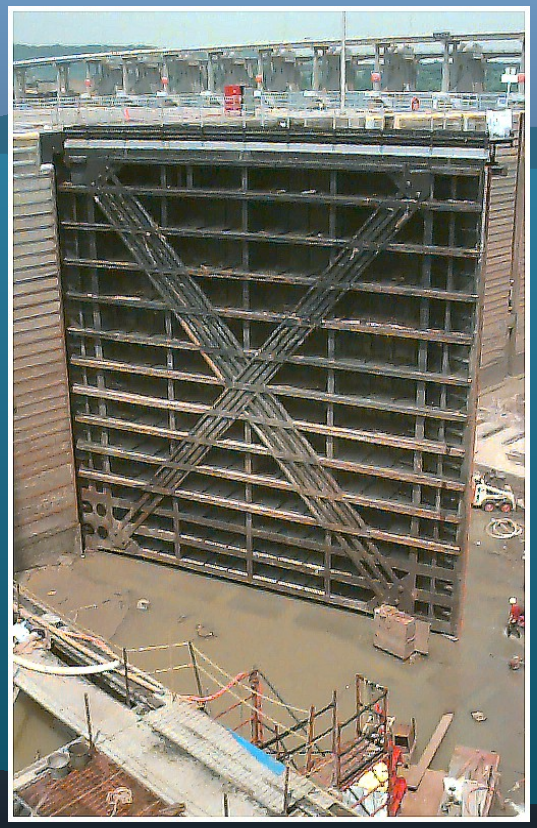
**Yazoo River Bank**



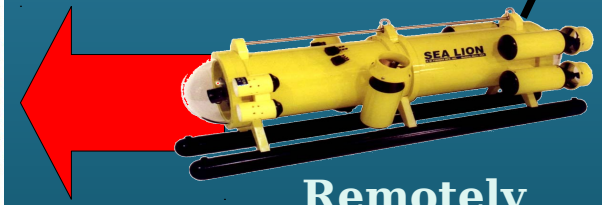
**Acoustical Image of Bank**

# High Resolution Acoustic Imaging C

## Underwater Inspections of Gates Using Acoustic Cameras



Operator Control




**Remotely Operated Vehicle With imaging system**

ERDC
Engineer Research and Development Center
Vicksburg Internet

# High Resolution Acoustic Imaging C

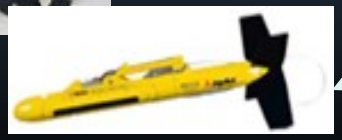
## Initial Acoustic Camera Deployment System

**Imaging System mounted on gunwale with a capability of pan and tilt, manual or automatic.**

**Developing an ROV for Ca**

ERDC
Engineer Research and Development Center
Vicksburg Internet

# High Resolution Acoustic Imaging C



***Objective: Develop & Construct A High-Resolution Acoustic Imaging System to Support The Corps' inspection activities and ERDC's research efforts.***

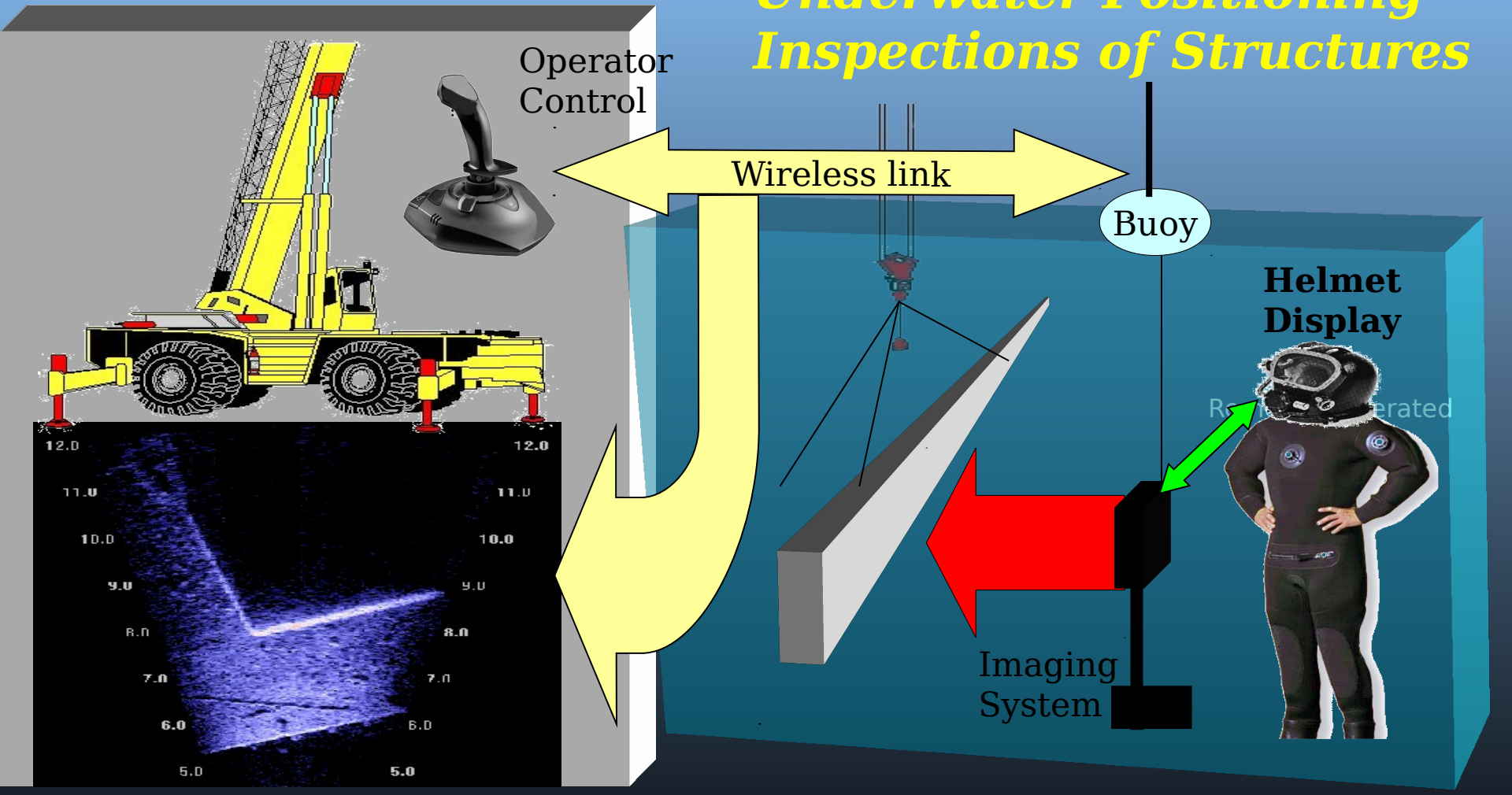
***System will include:***

- **A Boat with environmental controls**
- **Remotely operated vehicle (ROV)**
- **Acoustic Camera**
- **GPS location equipment**
- **Roll, and Pitch detection**
- **Side Scanner Sonar**

ERDC
Engineer Research and Development Center
Vicksburg Mississippi

# High Resolution Acoustic Imaging C

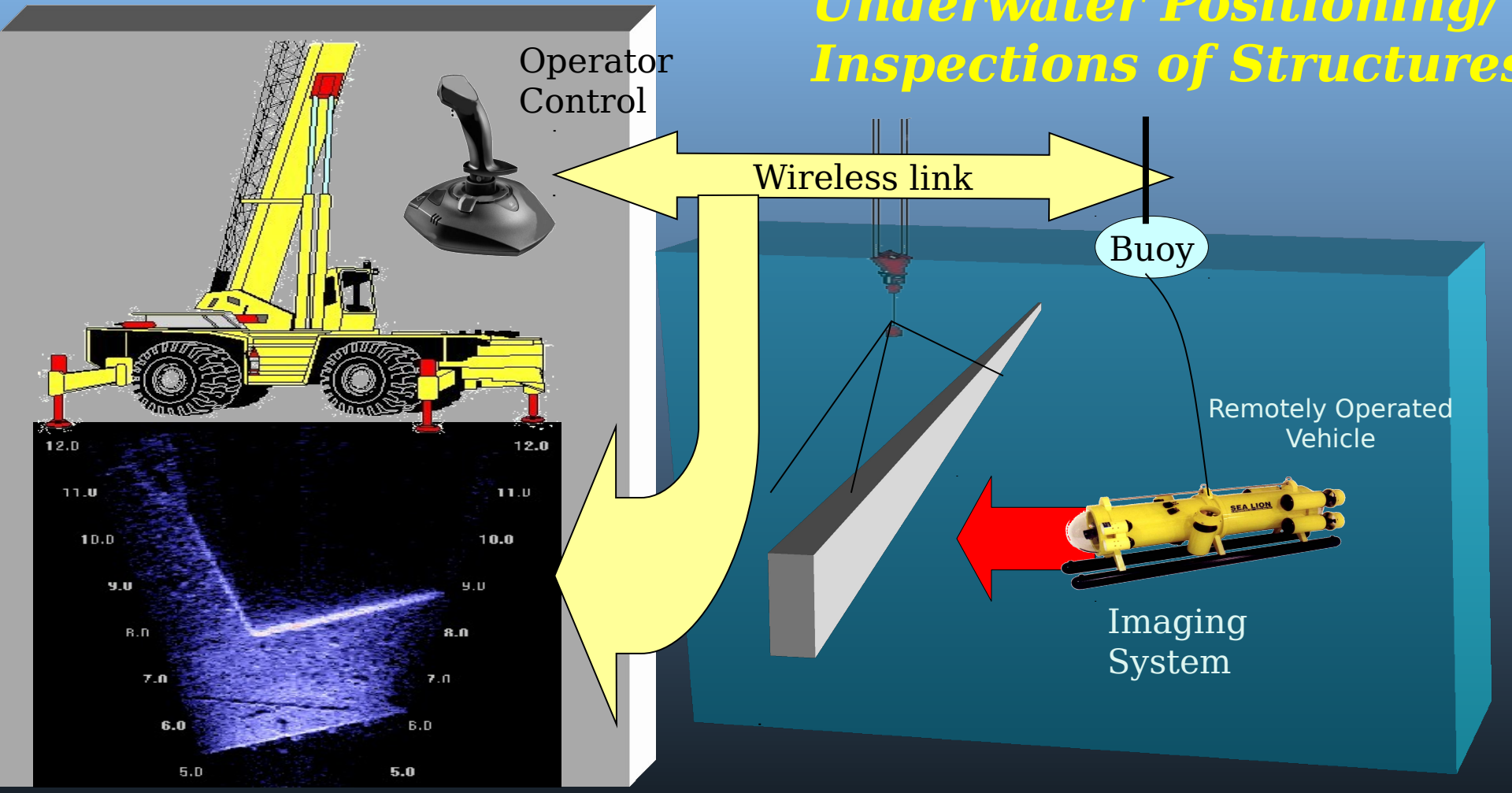
## Underwater Positioning
## Inspections of Structures




ERDC
Engineer Research and Development Center
Vicksburg Internet

# High Resolution Acoustic Imaging C

## Underwater Positioning/ Inspections of Structures

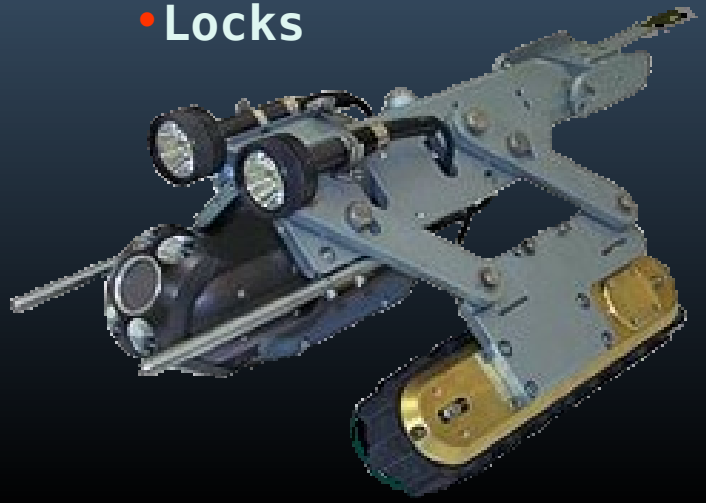



ERDC
Engineer Research and Development Center
Vicksburg Internet

# High Resolution Acoustic Imaging C

## Underwater Inspections of:

- outlet works
- spillway conduits
- toe drain systems
- penstocks
- pipelines
- Up/down stream dam faces
- Gates
- Locks



ERDC
Engineer Research and Development Center
Vicksburg Internet

# High Resolution Acoustic Imaging Camer
# Other Applications

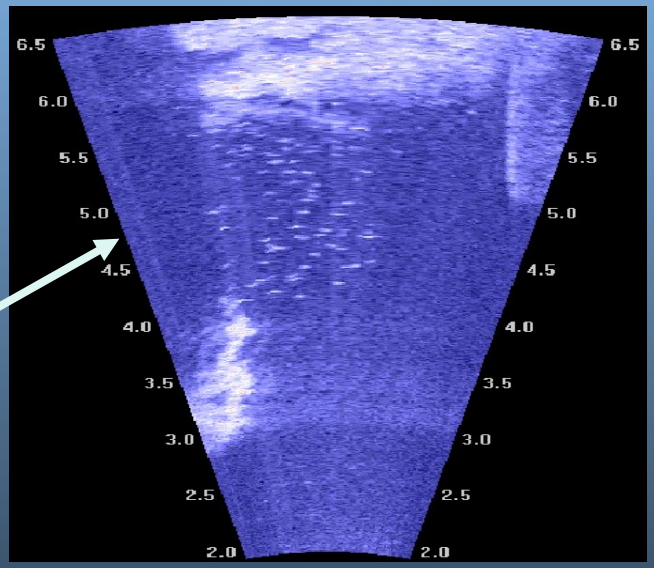
## cation of Endangered Species

**The National Environmental Policy Act (NEP of 1969 requires all Federal agencies to con the possible environmental impacts, includi threat to threatened species, of proposed actions during the planning and decision-m process.**

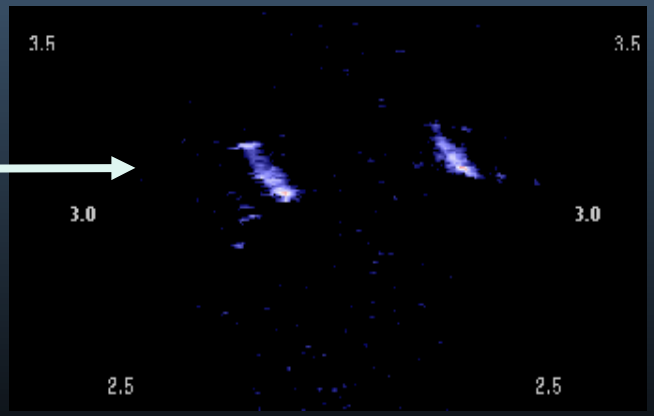
# High Resolution Acoustic Imaging Camera

- High Resolution along both cross ranges and down range.

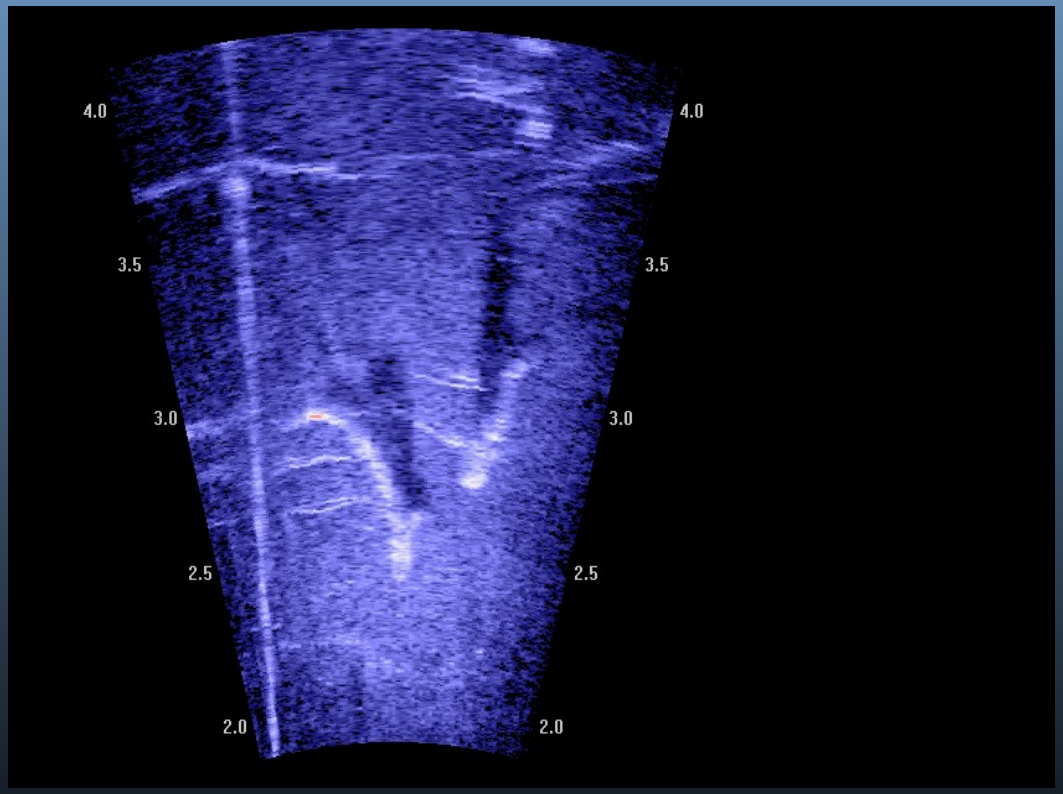
Acoustic Image of 2-Inch Minnows




9-Inch Trout Seen From 4 Meters



# *High Resolution Acoustic Imaging Camera*



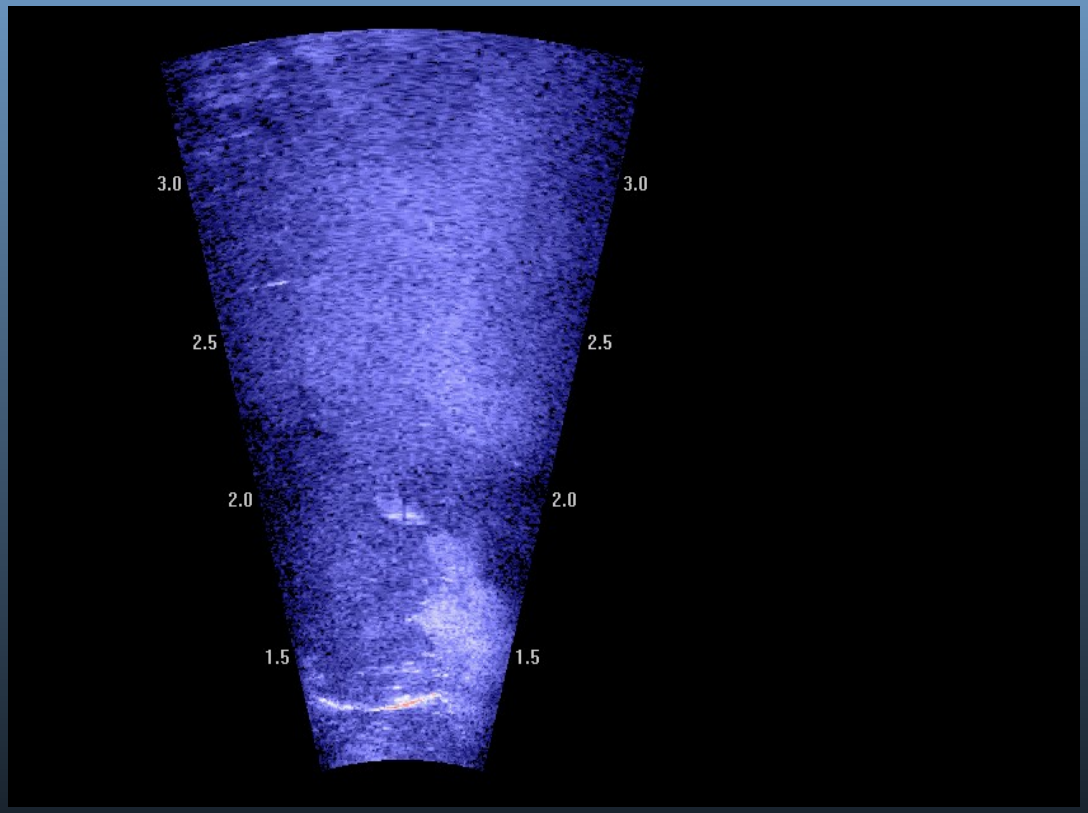

## *Identification of Fish species*

***Detection of Threatened and Endangered Species***

***Acoustical image of Sturgeon on left, catfish on right***

***(Test performed at***

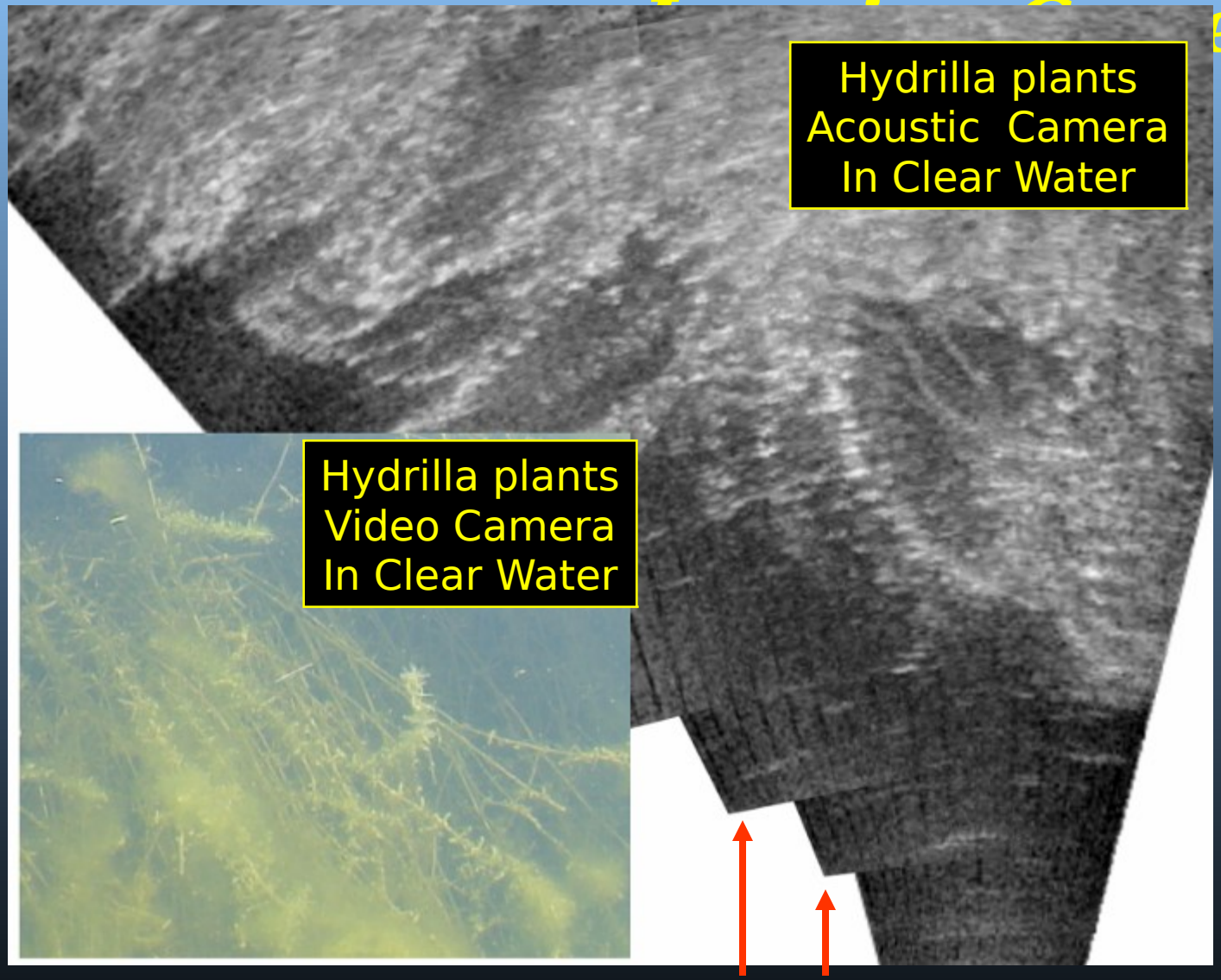
# High Resolution Acoustic Imaging Camera




## Identification of Fish Species

*Unexpected fish making u-turn near the camera. (Yazoo River - turbid water)*

# High Resolution Acoustic




Manually Mosiaced composite

# *High Resolution Acoustic Imaging Camera*

## *Projects Objectives*

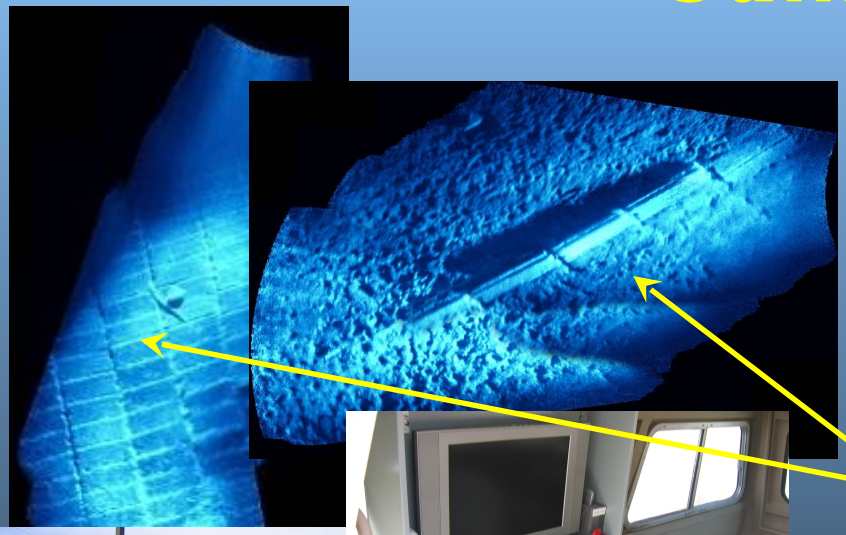
- **Enhance capability of systems by developing optimum deployment method**

- **Enhance capability of systems by developing additional stabilizing and focusing methods.**

- **Improve image by using advanced signal processing methods.**

- **Transfer information on the technology to the Corps of Engineers Districts and Divisions through workshop participation, Users Group, web sites, reports and demonstrations, etc..**

# High Resolution Acoustic Imaging Camera



## Summary Where we are NOW:

1) Improving the image using advanced signal processing.

2) Integrating camera system into a common platform (boat)

3) Transfer information on the technology to the Corps of Engineers Districts and Divisions through workshop participation,